NATIONAL RESEARCH COUNCIL
COMMISSION ON PHYSICAL SCIENCES, MATHEMATICS, AND APPLICATIONS
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BOARD ON
PHYSICS AND ASTRONOMY

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July 19, 1993

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Re: ET Docket No. 93-198

In the Matter of

Preparation for International
Telecommunication Union World
Radiocommunication Conferences

Dear Ms. Searcy:

Transmitted herewith by the National Academy of Sciences—National Research Council's Committee on Radio Frequencies are an original and nine (9) copies of its Comments in the above-referenced proceedings.

If additional information is required concerning this matter, please communicate with this office.

Sincerely,

Robert L. Riemer

Robert L. Riemer
Associate Director

Enclosure

No. of Copies rec'd 0+8
List A B C D E

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
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Preparation for International	)	
Telecommunication Union World	)	
Radiocommunication Conferences	)	

COMMENTS OF THE NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES

Bruce Alberts
President
National Academy of Sciences

July 19, 1993

Direct correspondence to

Dr. Robert L. Riemer
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HA-562
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Washington, D.C. 20418

Table of Contents

Summary

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies, requests that the Commission recommend the following in its report to the State Department on U.S. positions for the 1993 World Radiocommunications Conference (WRC-93):

(1) Consideration of the Report of the Voluntary Group of Experts at WRC-97 rather than WRC-95.

(2) Retention of Footnotes 726A, 730C, 733E, 734 and 735A in their present form. Consequently, these footnotes should not be included in the agenda of WRC-95 or WRC-97.

(3) Recognition of the need to protect certain radio and radar astronomy operations from out-of-band emissions that may be caused by BSS(Sound) systems using the allocations adopted at WARC-92 [assuming BSS(Sound) related issues are placed on the agenda for WRC-95 or WRC-97].

(4) Consideration at WRC-95 of primary allocations for wind profiler radar systems in the 400 and 915 MHz bands.

(5) Retention of primary allocations for the Earth Exploration-Satellite Service (passive) in the 10.68-10.7 and 15.35-15.4 GHz bands. These allocations should not be included in the agenda of WRC-95 or WRC-97.

(6) Consideration at WRC-95 of a primary allocation for the Earth Exploration-Satellite Service (passive) in the 18.6-18.8 GHz band.

(7) Consideration at WRC-95 of a secondary allocation and footnote protection for the Earth Exploration-Satellite Service (passive) in the 17.9-18.1 and 19.1-19.6 GHz bands and in a band near 6.7 GHz.

(8) Retention of International Footnote 713 concerning use of the 13.4-14.0 GHz band by the Earth Exploration-Satellite and Space Research Services. Footnote 713 should not be included in the agenda of WRC-95 or WRC-97.

(9) Retention of Earth Exploration-Satellite Service allocations near 23 GHz and recognition of the concerns of CORF expressed in the "Report of the MSS Above 1 GHz Negotiated Rulemaking Committee," April 6, 1993 (assuming intersatellite link allocations near 23 GHz are considered). These allocations should not be included in the agenda of WRC-95 or WRC-97.

(10) Continued exclusion of active satellite-based sensors from the existing primary allocation to the Earth-Exploration Satellite Service (passive) in the 36-37 GHz band.

(11) Any allocations in the space services should be consistent with CCIR Recommendation 314-8.

(12) Retention of Recommendation 701, adopted at WARC-79. Recommendation 701 should not be included in the agenda of WRC-95 or WRC-97.

(13) Retention of Recommendation 702, adopted at WARC-79. Recommendation 702 should not be included in the agenda of WRC-95 or WRC-97.

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JUL 1 9 1993

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

BEFORE THE

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WASHINGTON, D.C. 20554

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COMMENTS OF THE NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies ("CORF"), hereby offers its comments in response to the Commission's Notice of Inquiry ("NOI") released June 28, 1993, in the above-captioned proceeding.

I. INTRODUCTION

CORF is composed of both "active" and "passive" scientific users of the spectrum. Passive users include, for example, radio astronomers. Others, such as remote sensing researchers, acquire data through Space Research Service active and passive sensors and Earth-Exploration Satellite Service passive sensors, and both services use active transmission to send their data back to Earth. Similarly, meteorological researchers use both passive and active sensors and active transmission for data. Other active scientific uses include, for example, wildlife data telemetry.

Passive users do not transmit on the frequencies allocated to them; they only receive emissions on those frequencies.[1] The radiation emitted by natural processes is received as statistical "noise," but by carefully studying the intensity, frequency, position, polarization, and variation with time of the radiation, radio scientists can deduce information about the nature of the source of the radiation.

Unlike active users of the spectrum, passive users have little or no control over the frequencies that they need to use or the character of the "transmitted" signal. For observation of radio spectral lines (which are generated by specific atomic or molecular transitions), it is of course not possible for astronomers to relocate their operations to another band in order to accommodate alternative uses of the spectrum. For continuum observations, however, some adjustment of operating frequencies is usually possible.

Both the international and U.S. Tables of Frequency Allocations contain frequency bands designated for scientific purposes. Some of these allocations are in bands that will be the subject of discussion at the 1993 World Radiocommunication Conference ("WRC-93").

II. REPORT OF THE VOLUNTARY GROUP OF EXPERTS

The Commission states that the Voluntary Group of Experts ("VGE") will issue a report containing recommendations on simplification of the international Table of Allocations and Radio Regulations in the first half of 1994 (NOI at ¶ 4). CORF is interested in the work of the VGE and intends to carefully review the VGE report to ensure that the protection of bands used by radio scientists is not inadvertently weakened. CORF is concerned, however, that there may

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[1] The emissions or signals to which radio astronomers listen are extremely weak. A typical radio telescope receives only about one trillionth of a watt from even the strongest cosmic source.

not be sufficient time for interested parties to adequately review and comment on the report prior to the 1995 Conference, particularly if the VGE does not meet its stated schedule for issuing the report. Given the importance of the work being done by the VGE and the amount of time that the VGE participants have put into this massive undertaking, CORF believes the most prudent approach would be to place the VGE report on the WRC-97 agenda in order to ensure that it receives the attention it deserves. If, however, consideration of the report is placed on the agenda for WRC-95, then the United States should request prompt publication and circulation of the report so as to allow as much time as possible for interested parties to provide their input.

III. MOBILE-SATELLITE SERVICE

harmful interference to RAS stations, as a consequence of the allocations made to the MSS at WARC-92.

Similarly, Footnote 734, a footnote of long standing, was also modified following detailed consideration at the Conference as a consequence of changing the allocation of the RAS in this band from secondary to primary, a proposal for which had been made by the United States.

The other footnotes listed above were all modified as a consequence of the new allocations to the MSS. However, nothing has transpired since WARC-92 that would make any reconsideration of, or changes in, these footnotes appear necessary or desirable. Therefore, the United States should not propose that these footnotes be included in the agenda of WRC-93.

IV. BROADCASTING-SATELLITE SERVICE (SOUND)

CORF takes no position on whether there is a need to place any Broadcasting-Satellite Service (Sound) [BSS(Sound)]-related issues on the agenda for either WRC-95 or WRC-97. However, to the extent that BSS(Sound) issues are considered, CORF would like to take this opportunity to remind the Commission of the need to protect certain radio and radar astronomy operations from out-of-band emissions that may be caused by BSS(Sound) systems using the allocations adopted at WARC-92.

Specifically, the Radio Astronomy Service has a primary allocation in the 1400-1427 MHz band, which is used for hydrogen-line and continuum observations. The use of and justification for this allocation are described in Attachment 1, "Views of the Committee on Radio Frequencies Concerning Frequency Allocations for the Passive Services at the 1992 World Administrative Radio Conference" ("Views of CORF", National Research Council, 1991), at p. 24. In CORF's view, in order to ensure adequate protection of the Radio Astronomy Service,

BSS(Sound) transmissions in the 1452-1492 MHz band should be limited to the upper 25 MHz of the band.

CORF is also concerned about the interference that out-of-band emissions from BSS(Sound) operations in the 2310-2360 MHz band could cause to planetary radar studies being conducted at 2380 MHz at the Arecibo Observatory in Puerto Rico. These studies and the need to protect them are described in Attachment 2, "Comments of Cornell University," filed January 29, 1993, in General Docket No. 90-357.

V. WIND PROFILER RADAR SYSTEMS

The Commission requests comment on whether international wind profiler allocation issues should be addressed at WRC-95 or WRC-97 (NOI at ¶ 13). For the following reasons, CORF believes that such issues should be on the agenda of WRC-95.

The National Oceanic and Atmospheric Administration (NOAA) has expanded significantly its use of wind profiler radar systems in the 400 MHz band. NOAA operates a 30-station prototype wind profiler network in the central United States. Wind profiler radar systems are also employed by Colorado State University and Pennsylvania State University, which are engaged in climate and weather research. The National Center for Atmospheric Research (NCAR) is also considering employment of wind profilers in the near future. Low-power wind profilers operating at 915 MHz are also beginning to be widely used in NOAA research programs as a means of improving wind measurements near the Earth's surface. Since there are currently no existing allocations for wind profilers, operation of these systems has been on a non-interference basis.

In view of the growing use of wind profilers, it is imperative that allocations at 400 and 915 MHz for wind profiler radars be considered as soon as possible, which would be at WRC-95.[2]

VI. SPACE SERVICES

In paragraph 14 of the NOI, the Commission requests comments on matters raised in Resolution 12 concerning the space services. As explained below, a number of these matters are of interest to radio scientists and warrant consideration at a future conference.

A. Worldwide Primary Allocations for the Earth-Exploration and Space Research Services in the Appropriate Bands Within the 8-20 GHz Range

Passive satellite-, ground-, and aircraft-based radiometers operating in the 8-20 GHz range are extremely useful for weather prediction, severe storm monitoring, global climate monitoring, oceanography, and precision altimetry. The specific bands being used are (1) ~6.7 GHz (20-100 MHz),[3] (2) 10.68-10.7 GHz, (3) 15.35-15.4 GHz, (4) 17.9-18.1 GHz, (5) 18.6-18.8 GHz, and (6) 19.1-19.6 GHz. Collectively, these bands provide critical coverage of the spectrum at approximately octave intervals, with slightly denser coverage near the 22.235 GHz water-vapor line. They are particularly useful for measurement of sea state, ocean-surface wind speed, sea ice, rain state, and water vapor. Both operational and planned satellite sensors rely on the ability to observe the Earth in these bands without interference from

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[2] Adoption of allocations at 450 and 915 MHz would obviate the need for a wind profiler allocation near 50 MHz for operational systems; however, assignments near 50 MHz on a secondary basis would still be required by the research community.

[3] A 6.7 GHz channel is included here because it is located on the fringe of the 8-20 GHz range and currently has no protection.

communications systems.[4] Threshold interference levels can be determined using the analysis methods outlined in CCIR Reports 693-3 and 694-3.

Of the bands listed above, only the 10.68-10.7[5] and 15.35-15.4 GHz bands have primary allocations. These allocations must remain unchanged.

The 18.6-18.8 GHz band, while highly sensitive to oceanic precipitation and sea state, is shared with communications services and given only footnote protection. In order to retain the utility of this critical band, CORF recommends that WRC-95 consider allocating the 18.6-18.8 GHz band for passive Earth exploration on a primary basis.

For geophysical sensing, the 17.9-18.1 and 19.1-19.6 GHz bands are essentially as useful as the 18.6-18.8 GHz band and are currently in use on the operational satellites TOPEX/POSEIDON and the Defense Meteorological Satellite Program (DMSP) Block 5 series. However, the Earth Exploration-Satellite Service does not have protected status in these bands. The 19.1-19.6 GHz band will be used well into the next century on DMSP satellites, and follow-on instruments to TOPEX will likely be proposed. Given the expected use of these bands for at least a 10- to 15-year period, CORF believes it would be reasonable for the United States to propose a secondary allocation and footnote protection for passive Earth exploration operations in these bands.

The 6.7 GHz channel, which also is not protected, is very useful for measuring heavy precipitation over oceans as well as sea surface temperature. It also contributes useful information to measurements of oceanic wind speed. However, communications traffic and

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[4] Additional information on the use of these bands is contained in Attachment 1, Views of CORF, at pp. 28-29.

[5] It should be noted that this band is expected to be used on the proposed EOS Multifrequency Imaging Microwave Radiometer (MIMR).

spurious emissions in the band around this channel are expected to increase over the next decade. In fact, interference to the 6.6 GHz channel on the operational Scanning Multichannel Microwave Radiometer (SMMR) near populated areas is already occurring. Since a channel near 6.7 GHz is currently proposed for use on the EOS MIMR, it is also reasonable that a band near 6.7 GHz be given secondary allocation and footnote protection for passive Earth exploration.

Finally, CORF notes that the United States should ensure that International Footnote 713 is not compromised at a future conference because the 13.4-13.7 GHz band is currently being used by satellite-based radar altimeters.

VII. RECOMMENDATION 701

Recommendation 701, adopted at WARC-79, recommends that administrations:

> when preparing for the next competent administrative radio conference, should consider the question of making provisions in the 1330-1400 MHz band to provide the radio astronomy service with increased protection from services that radiate.

The importance of the 1330-1400 MHz band to radio astronomers is described in Attachment 1, Views of CORF, at p. 24. At present, radio astronomy use of this band has only footnote status (International Footnote 718). Nevertheless, the United States should ensure that no steps are taken at a future conference that would eliminate this minimum degree of protection. The footnote protection of this important band has been extremely useful to radio astronomy, and it is essential that this level of protection be maintained.

VIII. RECOMMENDATION 702

Recommendation 702, adopted at WARC-79, recommends that

> when preparing for the next competent administrative radio conference, administrations should consider the desirability of making provisions so as to provide a controlled environment suitable for the reception of extraterrestrial radiations in the 1400-1727 MHz, 101-120 GHz and 197-220 GHz bands.

The search for evidence of extraterrestrial radiation by radio astronomers is described in Attachment 1, Views of CORF, at p. 12. At present, radio astronomy use of the aforementioned bands has footnote status (International Footnote 722). The United States should ensure that no steps are taken at a future conference that eliminate this footnote.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

By: Bruce Alberts

Bruce Alberts
President
National Academy of Sciences

July 19, 1993

Direct correspondence to:

Dr. Robert L. Riemer
Associate Director

ATTACHMENT 1

VIEWS OF THE COMMITTEE ON RADIO FREQUENCIES

CONCERNING FREQUENCY ALLOCATIONS FOR THE PASSIVE SERVICES AT THE 1992 WORLD ADMINISTRATIVE RADIO CONFERENCE

Committee on Radio Frequencies
Board on Physics and Astronomy
Commission on Physical Sciences, Mathematics, and Applications

NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES
Washington, D.C. • 1991

VIEWS OF THE COMMITTEE ON RADIO FREQUENCIES

CONCERNING FREQUENCY ALLOCATIONS FOR THE PASSIVE SERVICES AT THE 1992 WORLD ADMINISTRATIVE RADIO CONFERENCE

Committee on Radio Frequencies
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National Research Council

NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES
Washington, D.C. • 1991

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Frank Press is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel [illegible]

COMMITTEE ON RADIO FREQUENCIES

R. MARCUS PRICE, University of New Mexico, *Chair*
WILLEM BAAN, National Astronomy and Ionosphere Center
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CONTENTS

I. INTRODUCTION

The scientific needs of radio astronomers and other users of the passive services for the allocation of frequencies were first stated at the World Administrative Radio Conference held in 1959 (WARC-59). At that time, the general pattern of a frequency-allocation scheme was

1. that the science of radio astronomy should be recognized as a service in the Radio Regulations of the International Telecommunication Union (ITU);

2. that a series of bands of frequencies should be set aside internationally for radio astronomy—these should lie at approximately every octave above 30 MHz and should have bandwidths of about 1 percent of the center frequency; and,

3. that special international protection should be afforded to the hydrogen line (1400-1427 MHz), the hydroxyl (OH) lines (1645-1675 MHz), and to the predicted deuterium line (322-329 MHz).

At the end of WARC-59, considerable action had been taken to meet these needs, and at subsequent conferences (with more limited tasks), the growing extent of the scientific needs has been stated and further steps taken to meet them.

The discovery of radio sources and the bulk of current knowledge about their nature and distribution, and of the processes responsible for the radio emission from them, have come through observations of the continuum radiation (continuous spectra) made at a limited number of frequencies at meter to centimeter wavelengths. Observations of intensity need to be made at a number of frequencies to determine the characteristic spectra of sources; but because the distribution of continuum radiation with frequency is relatively smooth, observations of this kind do not need to be made at specific or closely adjacent frequencies. Bands spaced at intervals of about an octave of the radio-frequency spectrum are normally satisfactory. However, some sources have spectral features requiring observation at closer spacings.

The bands made available to the Radio Astronomy Service, in accordance with the Final Acts of the World Administrative Radio Conference, Geneva, 1979, represent an improvement over the international allocations made to the Service in 1959, 1963, and 1971 and are a partial fulfillment of the requirements of the Service. However, many of the currently allocated bands have insufficient bandwidths; they are, in

most cases, shared with active services; many apply to limited areas of the world; and there are large intervals between some of the allocated bands.

As the 1992 WARC approaches, the Committee on Radio Frequencies (CORF) restates in this document the views and needs of radio astronomers and remote sensing scientists for the protection of their research. There is a continuing need for review and updating of the allocations of frequencies for the passive services. The committee notes that with the discovery of new astronomical objects and the development of better equipment and techniques, passive radio scientists regularly use frequencies from the lowest allocated radio astronomy band at 13360-13410 kHz to bands above 500 GHz. The use of passive ground- and satellite-based instruments for meteorological and astronomical observation has further increased the need for more spectrum.

The needs for continuum observations when first stated in 1959 were based largely on the desire to measure the spectra of radio sources over a wide range of frequencies. Since that time, two developments have reinforced this need for continuum bands.

First, pulsars, which are rapidly rotating, highly magnetized neutron stars, have been discovered to be among the most exotic objects in the universe. The physics of pulsars involves the study of matter and radiation under the influence of extreme magnetic, electric, and gravitational fields. Pulsars now provide the most accurate timekeeping, surpassing the world's ensemble of atomic clocks for long-term time stability. They provide the best experimental tests of predictions of the theory of general relativity, the detection of gravitational radiation, and diagnostics of the interstellar medium's density and magnetic field. For these studies continuum bands, particularly those at frequencies below 3 GHz, are most valuable.

Second, the technique of very-long-baseline interferometry (VLBI) now allows radio astronomers and earth scientists to link radio telescopes many thousands of kilometers apart by recording on fast-running, high-density magnetic tape (using very stable oscillators as a reference) and to process the tapes to produce an interferometer system with several very long baselines. The technique of VLBI has proved invaluable in studying the structure of very distant radio sources and in monitoring crustal motions and rotational irregularities of the earth. For this technique to be fully exploited, telescopes in several different countries must observe together on exactly the same frequency. This is made much easier if the same passive frequency bands are protected in all of the regions of the world.

Since 1959 a large number of spectral lines from a wide variety of atoms and molecules in space have been discovered. The frequency range of radio astronomy now extends to at least 500 GHz. In particular the CO molecule, with frequencies at 115, 230, and 345 GHz and isotopes with frequencies at 110, 220, and 330 GHz, is critical to many aspects of astronomy. The opportunity to learn about the gas out of which stars are formed in our own and in distant galaxies depends considerably on access to all of these frequencies. The ground-state fine-structure line of atomic carbon at 492 GHz has been discovered and provides a truly unique opportunity for radio astronomy. However, the protection of spectral-line frequencies is a difficult task. In some simple cases, what is needed is clear; the value of H, OH, and CO line studies has grown, particularly as more sensitive instruments look farther out to objects with increasingly greater red shifts. This, in turn, has made it urgent to look for ways to extend the hydrogen- and hydroxyl-line protection below 1400 MHz, and similarly to extend the protected bands for the lines of OH and CO molecules. For many of the new molecular species, it is difficult to be precise as to their relative scientific importance. Thus continued review of the science, combined with protection of radio astronomy observations by footnote references to the Table of Frequency Allocation in the ITU Radio Regulations, is needed.

There are special difficulties for some spectral lines (the OH lines, for example), where radio emissions from airborne and spaceborne transmitters exist too close to the line frequencies. This difficulty is one that, in recent years, has grown greatly in importance, particularly with the introduction of higher-